DEVELOPING A HEAT-RELATED SOCIAL VULNERABILITY INDEX FOR CORRECTIONAL FACILITIES

by
Clare Morganelli

A capstone submitted to Johns Hopkins University in conformity with the requirements for the degree of Master of Science in Energy Policy and Climate

Baltimore, Maryland
December 2020

Abstract

Climate change, driven by increasing greenhouse gas emissions, has caused and will continue to cause increasing temperatures across the United States (Hayhoe et al. 2018). Extreme heat contributes to a variety of health complications and illnesses, as well as death (Jones 2019). Some populations are more vulnerable to its impacts than others – one such population is the incarcerated population (Crimmins et al. 2016). The U.S. is responsible for 20 percent of the world's prisoners, and many correctional facilities lack adequate ventilation, air flow, and cooling equipment to protect incarcerated people from the life-threatening impacts of extreme heat (Holt 2015; Sawyer and Wagner 2020)

This project develops a comparison tool to integrate historical and projected heat index data with social vulnerability data, called the Correctional Facilities Heat Vulnerability Index (CFHVI). A research review of available data was conducted to determine which states and which demographic factors to include in the CFHVI. Seven geographically representative states were selected from the contiguous 48 states, along with three factors for each category: incarcerated population factors, staff factors, and facility factors. The results of the tool indicate that states with high CFHVI results, corresponding with high vulnerability to heat, should be prioritized in receiving adaptive measures to avoid health complications from heat among inmates and staff in correctional facilities.

Historical, mid-century, and late century data for the projected average number of days with a heat index of 90°F were used from the Union of Concerned Scientists, at the state level and at the county level for counties containing correctional facilities in each state (Dahl et al. 2019). The results indicate that observing just heat index data is an incomplete picture to assess the vulnerability of an incarcerated population, though significant data limitations did impact results. The paper makes recommendations about how to reduce heat-related health impacts in correctional facilities, by collecting and reporting data, implementing adaptive measures like air conditioning, and reducing the overall prison population in the United States.

Primary Reader and Advisor: Juanita Constible

Secondary Reader: Dr. Daniel Zachary

Acknowledgements

I'm extremely grateful to my advisor, Juanita Constible, for her thoughtful guidance, unwavering patience, and persistent encouragement throughout the duration of this project. Her direction academically, professionally, and personally has profoundly influenced my work, and this project would not be possible without her support.

Contents

List of Tables

1. Introduction

The United States has one in five of the world's prisoners, the largest incarcerated population of any country (Sawyer and Wagner 2020). Correctional facilities get hot and stay hot due to use of heat-trapping building materials like concrete and metal and limited airflow and ventilation, and because of a lack of adaptive measures that protect especially vulnerable prison populations from heat. Certain populations of incarcerated people, including those with existing health conditions and older individuals, are more susceptible to heat-related illnesses. Some claim that subjecting incarcerated people to too-hot temperatures could be considered a violation of "reasonably safe" conditions as guaranteed by the Constitution (Holt 2015). With continued climate change, average temperatures are rising and extreme heat events are expected to increase in severity, frequency, and duration across many regions of the country (Jay et al. 2018).

Climate Change and Heat in the U.S.

Continued global greenhouse gas emissions from the burning of fossil fuels are driving human-caused warming of the planet. It is extremely likely that more than half of the global average temperature increase over the period 1951 to 2010 was caused by human activity (Knutson et al. 2017). Representative Concentration Pathways (RCPs) help modelers develop projections of future climate change and provide an idea of what the future holds with different levels of emissions (Jay et al. 2018; Hayhoe et al. 2018). Because future human activity and subsequent emissions are uncertain, and because climate models are based upon a variety of assumptions, the magnitude, speed, and exact impacts of these emissions on the Earth's climate system may vary over the next decades and centuries (Hayhoe et al. 2018).

The United States has seen warming of about 1.2°F over the last few decades (1986 – 2015). The contiguous United States is projected to see an increase in annual average temperature of 2.5°F over the next few decades, regardless of changes in emissions (Hayhoe et al. 2018). By the end of the century, increases in annual average temperature could range from 3°F to as much as 12°F. Each region within the U.S. has experienced warming at different levels and different rates. The largest increases are happening in the Western U.S., with Alaska, the Northwest, the Southwest, and the Northern Great Plains experiencing increases of more than 1.5°F over the past few decades compared to the first half of the 1900s (Hayhoe et al. 2018).

Incarceration in the U.S.

There are a variety of different ways people are held by the criminal justice system in the United States. In total, the system holds almost 2.3 million people, spread across state and federal prisons, state psychiatric hospitals, local jails, immigration detention facilities, juvenile detention facilities, civil commitment centers, military prisons, jails on Indian territory and prisons in U.S. territories (Sawyer and Wagner 2020). The largest population are those residing in state prisons, at 1,291,000 people, followed next by local jails at 631,000 people (Sawyer and Wagner 2020). Colloquially, the words "prison" and "jail" are used interchangeably, when they actually have separate definitions. Going to "prison" generally involves a more serious conviction with a sentence of longer than one year. A "jail" is where people await trial or serve out shorter sentences (usually misdemeanors) under a year (Sawyer and Wagner 2020).

The demographics of the prison population vary, but people of color make up a disproportionate percentage of incarcerated people compared to the U.S. population overall. In 2018, one white man was incarcerated for every 5.8 Black men, and one white woman was incarcerated for every 1.8 Black women. There are 7.46 non-Black members of the U.S. population for every one Black person, highlighting this disparity in incarceration (Carson 2020; U.S. Census Bureau 2019). This also mirrors the effects of other structural and societal inequities, including but not limited to health outcomes, access to education, wealth, and impacts from climate change.

Impacts of Climate Change on Prisoners

Extreme heat is the leading cause of weather-related mortality in the United States, with average deaths outnumbering those from hurricanes, tornadoes, lightning, floods, and winter temperatures over a 30-year period (Holt 2015; National Weather Service 2019; Public Health Institute 2016). Mora et al. (2017) details 27 ways a heat wave can kill you, but extreme heat causes a number of non-deadly health impacts including heat stress, heat cramps, heat exhaustion, dehydration, and heat stroke (Crimmins et al. 2016; Jones 2019). Exposure to extreme heat can also damage the liver, kidneys, lungs, heart, and brain (Jones 2019). Some groups, including pregnant individuals, those with preexisting health conditions, and the elderly, are especially vulnerable to heat (Crimmins et al. 2016). The prison population, like the U.S. population overall, is gradually aging; in 2019, people over 65 years of age experienced more than 102 million more days of heatwave exposure in the United States compared to the period 1986 to 2005 (Holt 2015; Salas et al. 2020). Individuals may struggle to regulate their body temperature if living with conditions like diabetes or obesity, or are taking certain medications including many used to treat high blood pressure or mental health conditions. While inmates are especially vulnerable, these same impacts can affect facility employees as well (Holt 2015).

Incarceration means more than just confinement. Often, able-bodied incarcerated people are required to work; this can mean jobs within the facility itself, for state-owned or private industries, or outside of the facility in work camps or community work centers. Assignments include taking calls at call centers, readying packages for shipment, producing or sewing goods, doing agricultural work, and even fighting wildfires (Fathi 2018; Sawyer 2017). Working outdoors in extreme heat or in too hot or poorly ventilated indoor environments can result in direct health impacts of heat, as well as safety risks from sweaty hands, dizziness, or trouble concentrating (NIOSH 2020). Typically, incarcerated people make under a dollar an hour - if they are paid at all - and don't have the luxury of calling out sick or taking time off to recover from complications from heat exposure (Benns 2015; Sawyer 2017).

Aside from direct health impacts of climate change, an additional risk facing both inmates and facility staff is the emerging relationship between heat and violence (Holt 2015; Mares and Moffett 2019; Stevens et al. 2019). While the research isn't settled, hotter temperatures have been correlated with an increase in aggressive behavior. Stevens et al. (2019) suggests occurrences of assault and theft were significantly higher in summer months than in winter. Rising summer temperatures could lead to higher rates of aggression and violence inside of correctional facilities, as well as higher rates of violence that can get people arrested in the first place (Miles-Novelo and Anderson 2019). Mares and Moffett (2019) postulate that climate change may have added 75,000 crimes annually in the U.S. in recent years and predict a one percent increase in crime levels for each additional degree Celsius of warming. Many correctional facilities already operate at or above capacity and increasing crime rates in warmer months could cause prison overcrowding and more outbreaks of violence, straining staff (Anderson and Anderson 1996; Anderson 2001; Holt 2015; Mares and Moffett 2019).

One of the most straightforward ways to reduce impacts from heat is to provide fans, air conditioning, access to water, and other cooling methods in facilities to inmates and to staff. Jones (2019) identified thirteen states in already too hot areas of the country that lack universal air conditioning in prisons: Alabama, Arizona, Florida, Georgia, Kansas, Kentucky, Louisiana, Mississippi, Missouri, North Carolina, South Carolina, Texas, and Virginia. Air conditioning is still considered a luxury to many Americans; the study indicates that withholding air conditioning is sometimes used as a political tactic to appear "tough on crime," citing a proposed prison in Louisiana that did not get the go-ahead by vote to open a new prison until leaders agreed inmates wouldn't be "pampered" with air conditioning

(Blinder 2016; Jones 2019). However, prisoners are entitled to “reasonable safety” under the Constitution and are guaranteed this “basic human need” be provided by the state – one could argue that protection from extreme heat is reasonable (Holt 2015).

There is some existing literature examining the relationship between climate change and incarceration in the United States. This project aims to develop a Correctional Facilities Heat Vulnerability Index (CFHVI) to compare vulnerability to heat between individual correctional facilities or states. The CFHVI will combine social/demographic vulnerability of incarcerated populations with heat index projection data. The intended audience utilizing the CFHVI are states or localities, to determine which facilities in their jurisdiction are at heightened risk of heat related illnesses and associated health impacts and in most need of adaptive measures. Because of significant data availability obstacles, the CFHVI will be demonstrated using state-level data as a representative example.

2. Methods

The main deliverable of this project is the Correctional Facilities Heat Vulnerability Index (CFHVI), with a representative run of data at the state level to demonstrate its use. The CFHVI was loosely modeled on methods used by the Centers for Disease Control and Prevention (CDC) to develop their Social Vulnerability Index (SVI) and Flanagan et al. (CDC 2020; Flanagan et al. 2011). The rationales are similar: to determine where to concentrate resources in order to support socially vulnerable groups; in the case of Flanagan et al., social vulnerability was used to determine where to provide social services and public assistance following a natural disaster (2011). The CFHVI is a comparison tool, intended to compare individual facilities within a jurisdiction against each other, rather than a tool calculating a numerical result using the data points directly. The results of the Index show which facilities (states, in this example) are more vulnerable than others based on selected factors and heat index projections.

The steps in completing this project were: 1) review available data across states and determine which states to compare; 2) based on the findings from step 1, determine which factors, or data points, to include in the CFHVI; 3) for the states selected, pull historical and projected heat index data at both the state average level and for the average value for counties containing correctional facilities; 4) run the index for each temperature scenario; 5) compare results between states. Each step is detailed further in this section, below.

Data Review and State Selection

An investigation of publicly available state-level incarceration statistics was conducted, to determine which states had the most robust data available. The first step was determining if states published any data at all, and then reviewing what was reported. Minimum requirements for a state to be considered included race and age breakdowns for inmates, race breakdowns for staff, levels of security for inmates, age of facilities, and capacity of facilities. Other factors, outlined further below, were included as well, though these were baseline factors.

Since the different regions of the United States are experiencing climate change differently, it was important to use a geographically diverse sample of states. One state from each of the seven contiguous regions defined by the Fourth National Climate Assessment (NCA4) were selected (Figure 1). Initially, the nine regions prescribed by the National Oceanic and Atmospheric Administration were going to be used due to greater granularity, but after an initial data review it became clear that states with available data were better dispersed throughout the NCA4 regions.

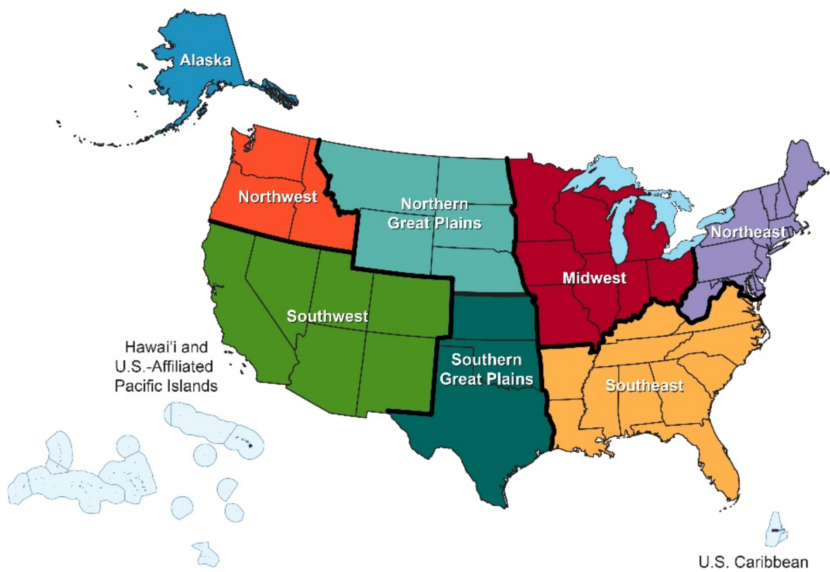

Figure 1: Fourth National Climate Assessment regions (Jay, et al. 2018).

The seven states selected were: Oregon (Northwest); Colorado (Southwest); Montana (Northern Great Plains); Kansas (Southern Great Plains); Arkansas (Southeast); Ohio (Midwest); and Delaware (Northeast). Each of these states offered the desired data points, plus others, at comparable scales.

<u>Selected Index Factors</u>

Selected index factors or "social" factors fall into three main categories: incarcerated population data; staff data; and facility data. Tables 1, 2, and 3 below outline the chosen factors and the reasoning behind their inclusion.

Table 1: Incarcerated population index factors.

Incarcerated Population Factor	**Reasoning**
% People of Color (POC)	People of color face increased risk of heat-related illness, as well as health complications like diabetes or heart disease, that can exacerbate heat-related illness (EPA 2020; Vaidyanathan et al. 2020). Due to discriminatory policies, historical disenfranchisement, and environmental racism, people of color are more likely to live in hot urban settings, face economic uncertainty, and deal with health disparities (Dahl et al. 2019). Data is from state departments of correction, reported for 2017 or 2018.
% Over 55	Older individuals are more susceptible to heat-related illness because the body has a more difficult time regulating temperature with age. Additionally, older individuals are more likely to live with illnesses that can exacerbate heat-related illness and are several times more likely to die from heat-related illness and complications (EPA 2020; Vaidyanathan et al. 2020). Data is from 2014, obtained from Prison Policy Initiative (2020).
% Medium to High/3+ Security Level	People incarcerated in higher-security facilities are likely to have limited movement outdoors and access to windows, to live in "fortress-like" facilities built with heat-trapping materials like concrete, brick, and metal, and are at greater risk of "needing to suffer" for their wrongdoings (Holt 2015). Data is from state departments of correction, reported for 2017 or 2018.

Table 2: Staff population index factors.

Staff Population Factor	**Reasoning**
% People of Color (POC)	People of color face increased risk of heat-related illness, as well as health complications, like diabetes or heart disease, that can exacerbate heat-related illness (EPA 2020; Vaidyanathan et al. 2020). Data is from state departments of correction, reported for 2017 or 2018.
% Women	Heat-related deaths are reported most frequently in males, as was the incidence of heat stroke (Alele 2020; CDC 2017). Data is from state departments of correction, reported for 2017 or 2018.
Ratio of Staff to Inmates	A greater number of inmates per staff member could lead to exhaustion, dehydration, lack of breaks, or over exertion in high-temperature settings for staff members (Holt 2015; NIOSH 2020). Data is from state departments of correction, reported for 2017 or 2018.

Table 3: Facilities index factors.

Facility Factor	Reasoning
Total Number of Inmates	Higher numbers of incarcerated people in a facility without adaptive measures would indicate greater incidence of heat-related illness, as well as chances of overcrowding (Holt 2015). Data is from state departments of correction, reported for 2017 or 2018.
Average Age of Facilities	Older facilities are less likely to incorporate heat-mitigating measures like fans, windows, passive cooling, and air conditioning (Holt 2015). Data is the average age of all correctional facilities in a state, obtained from the state departments of correction.
Capacity	Average percent capacity for the year reported. Overcrowding can make heat feel worse, as individuals themselves are sources of heat (Holt 2015). Data is from state departments of correction, reported for 2017 or 2018.

Future Temperature Projections

In order to incorporate future temperature projections and capture increasing temperatures with continued emissions and worsening climate change, data from the Union of Concerned Scientists' (UCS) study *Killer Heat in the United States* was utilized (Dahl et al. 2019). This dataset was selected for a number of reasons. First, UCS uses the heat index, a value that combines air temperature with relative humidity to indicate what the temperature feels like to the human body (Dahl et al. 2019; National Weather Service n.d.). When studying the impacts of extreme heat on people's health and wellbeing, this is a more realistic and accurate measure of how it feels to live in these temperatures (Dahl et al. 2019). Because humidity varies regionally across the United States, this provides more geographically consistent temperature data than just a thermometer measurement. Secondly, the UCS data is available at the state, county, and city levels. Especially for larger states or states with diverse geographies, like Colorado, state-wide average temperature projections may not truly represent the locations in which there are prison facilities.

There are three temperature scenarios included in the index, for comparison over time. The Union of Concerned Scientists' data offers days per year with a heat index over 90°F, 100°F, 105°F, and “off the charts,” which represents days when the temperature and humidity exceed the limits of the National Weather Service’s heat index calculations (Dahl et al. 2019). For the purposes of this project, 90°F was selected because this is already a high temperature to be living in, and is at the upper-end of the “caution” category in which the National Weather Service measures “likelihood of heat disorders with prolonged exposure or strenuous activity,” (n.d.).

There are three different timeframes for each of the temperatures in the data set for projected heat index days per year based on the average over a 30-year period. The first is “historical” data, representing the average days with a heat index above 90°F for 1971 to 2000, the second is “midcentury,” representing the average over 2036 to 2065, and the third is “late century” representing the average over 2070 to 2099 (Dahl et al. 2019). A “slow action” emissions reduction scenario was chosen over “no action” and “rapid action” scenarios, both of which seemed unlikely given the push and pull of political, scientific, and economic factors contributing to continued climate action around the world.

Running the Index

The main components of the CFHVI are:

- Location: states, or individual facilities if utilizing the index at a more granular scale.
- Factor: a characteristic of the incarcerated population, staff, or facilities in a certain location; for example, % People of Color. Each location has data available for each factor.
- Rank: A numerical ranking of the data for the locations for each factor; the highest value corresponds with the greatest heat vulnerability, and the lowest value with the lowest heat vulnerability.
- Percentile: A calculation of (rank – 1)/(# of locations – 1).

- Social Vulnerability Index (SVI): A comparison of the vulnerability using index factors, without inclusion of heat index data. More on this component in the section *Selected Index Factors.*
- Heat Index Projections: heat index projection data from the Union of Concerned Scientists, for historical, midcentury (slow action), and late century (slow action) heat index scenarios. More on this component in the section *Temperature Projections*.
- Correctional Facilities Heat Vulnerability Index (CFHVI): A comparison of vulnerability incorporating both social and heat index factors, and the final results of this paper.

Social Vulnerability Index

For each selected index factor (detailed in *Selected Index Factors*), data for each state was added into a spreadsheet across the three categories: incarcerated population data, staff population data, and facility data. After data for all seven states was incorporated, they were ranked from one (corresponding with the lowest heat vulnerability) to seven (corresponding with the highest heat vulnerability). Once the data were ranked, percentile values were calculated using the following equation:

$$Percentile = \frac{(rank - 1)}{(number\ of\ locations - 1)}$$

For each category of factors, the percentiles across the factors for each state were summed. This gave a total percentile for incarcerated population data, staff population data, and facility data. Then, the three percentiles are summed for each state, and ranked following the above procedure. The percentile for this rank is then found, which represents the Social Vulnerability Index for each state as a value between zero and one.

State-level Warming

For the state-level runs, whole-state data was downloaded from the UCS dataset (Dahl et al. 2019). Then, three separate runs were conducted for each state: 1) Historical Heat Index Days Above 90°F; 2) Difference In Heat Index Days Above 90°F Between Midcentury, Slow Action and Historical Heat Index Days Above 90°F; and 3) State Difference Between Late Century, Slow Action and Historical Heat

Index Days Above 90°F. For the "difference" runs, the historical number of heat index days was subtracted from both the Midcentury, Slow Action data points and the Late century, Slow Action data points for each state.

These values are ranked within their runs, and the percentile is found using the same calculation of (rank – 1)/(number of states – 1). This percentile is then is summed with the Social Vulnerability Index to give the final Correctional Facilities Heat Vulnerability Index for each state. The largest value corresponds to the highest vulnerability, and the lowest value the lowest vulnerability.

County-level Warming

Similarly, the index is run incorporating county-level data. Instead of using all counties in a state, only data from the counties containing correctional facilities are included. The UCS county-level data was downloaded, and corresponding Heat Index Days were pulled for each county containing a correctional facility in each state. Then, the average of heat index days for Historical, Midcentury, and Late Century were calculated. Three runs at the county-level follow the same process as the whole-state runs: 1) State Historical Heat Index Days Above 90°F; 2) Difference Between Midcentury, Slow Action and Historical Heat Index Days Above 90°F; 3) Difference Between State Late Century, Slow Action and Historical Heat Index Days Above 90°F. These values are then ranked, the percentile found and summed with the Social Vulnerability Index and compared.

Ties

In the event of a tie at any point in the index, the rank or vulnerability following the tie was skipped. For instance, if the CFHVI produced two states tied for lowest vulnerability, "1," then the next highest vulnerability would be assigned "3," skipping "2."

<u>Limitations</u>

The states and factors chosen to be included in the CFHVI were largely contingent upon data availability. Unfortunately, there is no consistent or standardized method nationwide for statistical reporting or data analysis around correctional facilities; states seem to be free to publish data as they please, and in whatever format they please. Some states post annual statistics tables, others publish full reports, and many disperse this information across numerous documents and across multiple years and scales. Therefore, this is not an exhaustive examination of all factors that influence a population's vulnerability to heat, and some limitations exist for the data that was included. For example, some of the chosen states reported data from 2017, while others reported for 2018. Some states collect data for the calendar year, others the fiscal year.

In some instances, staff demographics were given in the aggregate, not broken down by role. This includes administrative staff, cleaning staff, and other staff not directly engaged with securing the facility and managing incarcerated populations. Because of these data limitations, statistics on the total overall staff were used regardless of role. Removing potential factors that contribute to social vulnerability but were too inconsistent in reporting, such as "inmate needs" which included anything from mental and physical health conditions to drug use and addiction to pregnancy, was also necessary to ensure that data could be reasonably compared within the CFHVI.

Additionally, the SVI is built utilizing historical data reported by the state departments of correction in 2017 or 2018 (depending on the state), for inclusion in all runs of the CFHVI over the next century. Inmate demographics can shift, as can policing practices, sentencings, and other factors influencing incarceration, resulting in different SVI results over time.

3. Results

<u>Social Vulnerability Index</u>

The Social Vulnerability Index results, without inclusion of temperature data, are below in Table 4.

Table 4. Social Vulnerability Index results.

State	Social Vulnerability Index	Vulnerability Rank
Arkansas (Southeast)	0.50	4
Colorado (Southwest)	0.83	6
Delaware (Northeast)	1.00	7 - Highest
Kansas (Southern Great Plains)	0.33	3
Montana (Northern Great Plains)	0	1 - Lowest
Ohio (Midwest)	0.67	5
Oregon (Northwest)	0.17	2

The social vulnerability index places Montana (Northern Great Plains) at the least socially vulnerable and Delaware (Northeast) as the most socially vulnerable.

Heat Index Results

The results of the heat index vulnerability, without inclusion of the social vulnerability index, is below in Table 5.

Table 5. Heat-index results and vulnerability ranks.

State	Historical (State)	Vuln. Rank	Historical (County)	Vuln. Rank	Midcentury, Slow Action (State)	Vuln. Rank	Midcentury, Slow Action (County)	Vuln. Rank	Late Century, Slow Action (State)	Vuln. Rank	Late Century, Slow Action (County)	Vuln. Rank
AK (S.E.)	1.00	7	1.00	7	1.00	7	1	7	0.67	5	0.67	5
CO (S.W)	0.17	2	0.33	3	0.33	3	0.33	3	0.17	2	0.33	3
DE (N.E)	0.67	5	0.67	5	0.67	5	0.83	6	0.67	5	0.83	6
KS (S.G.P.)	0.83	6	0.83	6	0.67	5	0.67	5	0.50	4	0.50	4
MT (N.G.P.)	0.33	3	0.17	2	0.17	2	0.17	2	0.17	2	0	1
OH (M.W.)	0.50	4	0.50	4	0.50	4	0.50	4	0.67	5	1	7
OR (N.W.)	0	1	0	1	0	1	0	1	0	1	0.17	2

Looking at the heat index-only results, without inclusion of the social vulnerability index, Arkansas (Southeast) has the highest vulnerability to just the heat index for historical and midcentury at both the state and county level. For Late Century at the state level, Arkansas (Southeast) tied with Delaware (Northeast) and Ohio (Midwest). For Late Century at the county level, Ohio surpassed both Delaware and Arkansas for highest vulnerability. Oregon (Northwest) consistently had the lowest vulnerability for all runs except Late Century at the county level, where it was surpassed by Montana (Northern Great Plains) for lowest vulnerability.

Correctional Facilities Heat Vulnerability Index (CFHVI) Results

The results of the CFHVI and their associated ranked vulnerability (“rank”) are below in Table 6. The SVI results are included for comparison.

Table 6. CFHVI Results with SVI results.

State (Region)	SVI	Rank	Historical (State)	Rank	Historical (County)	Rank	Midcentury, Slow Action (State)	Rank	Midcentury, Slow Action (County)	Rank	Late Century, Slow Action (State)	Rank	Late Century, Slow Action (County)	Rank
AK (S.E.)	0.50	4	1.50	6	1.50	6	1.50	6	1.50	6	1.33	6	1.67	6
CO (S.W.)	0.83	6	1.17	3	1.17	3	1.17	4	1.17	4	1.00	4	0.83	3
DE (N.E.)	1.00	7	1.67	7	1.67	7	1.67	7	1.83	7	1.67	7	1.83	7
KS (S.G.P.)	0.33	3	1.17	3	1.17	3	1.00	3	1.00	3	0.83	3	1.17	4
MT (N.G.P.)	0	1	0.17	1	0.17	1	0.17	1	0.17	1	0.17	1	0.0	1
OH (M.W.)	0.67	5	1.17	3	1.17	3	1.17	4	1.17	4	1.17	5	1.17	4
OR (N.W.)	0.17	2	0.17	1	0.17	1	0.17	1	0.17	1	0.17	1	0.33	2

The Social Vulnerability Index (SVI) results are included for comparison. Observing the data side-by-side, two items are obvious: Delaware (Northeast) has the highest Social Vulnerability Index, as well as the highest vulnerability for every run of the CFHVI. Additionally, Montana (Northern Great Plains) has the lowest Social Vulnerability Index, as well as lowest vulnerability for every run of the CFHVI, tying with Oregon (Northwest) for every run of the CFHVI except for the Late Century, Slow Action run at the county level.

Also of note are Colorado (Southwest) and Ohio (Midwest) having relatively high SVI results, but integration with heat data across runs reduces the overall CFHVI results for these states. The opposite can be observed for Arkansas (Southeast), which had a lower SVI result than Colorado (Southwest) and Ohio (Midwest), but consistently higher CFHVI results.

4. Discussion

Discussion of Results

The Correctional Heat Vulnerability Index results showcase that assessing the heat vulnerability of incarcerated populations and staff would be incomplete without incorporating social factors; looking at heat index projections alone is insufficient and only partially representative.

When looking at only the heat index projection scenarios, without incorporating the social vulnerability, Arkansas (Southeast) has the highest heat index vulnerability for historical runs at both the county and state levels and Midcentury, Slow Action runs at both the county and state levels. The Southeast has consistently high heat indexes due to high temperatures and a humid climate, so this result is not particularly surprising (Hayhoe et al. 2018). Additionally, the Southeast has experienced significant nighttime warming, with the number of nights with temperatures above 75°F doubling on average compared to the first half of the century (Carter et al. 2018). High nighttime temperatures can make it difficult for incarcerated people's bodies to cool down after a very hot day and contributes to heat-related illnesses and complications (Holt 2015).

Delaware (Northeast) is an interesting example of how progressive prison policy can reduce the overall detained population and still increase the relative proportion of those vulnerable. The Social Vulnerability Index indicates that Delaware has the highest social vulnerability and consistently ranked the highest for most vulnerable across the Correctional Facilities Heat Vulnerability Index runs. There are a few factors contributing to Delaware's high vulnerability: high percentage of people of color among the inmates and the staff, high average age of facilities, and high percent capacity of facilities (Delaware Department of Corrections 2018). However, the factor that sticks out the most is the percentage of inmates classified as at least a medium security level. Delaware only incarcerates individuals receiving a Level V sentence; other sentence levels involve community corrections, probation, or house arrest (Delaware Department of Corrections 2018). Therefore, the percentage of their high-security incarcerated population is 93 percent, compared to other states with 30 to 60 percent of the population classified as medium to high security with a larger percentage of lower-level inmates (Delaware Department of Corrections 2018). Due to focusing resources on alternatives to 24-hour incarceration, Delaware's Department of Corrections has experienced a steady decline in the overall Level V population as well as the average length of stay over the past few years (Delaware Department of Corrections 2018).

While Delaware's practices and policies around people convicted of a crime are more progressive than other states, incarcerated individuals are still highly vulnerable to heat as indicated by the CFHVI results. This represents some of the disparities between the ways correctional operations are conducted across different states. If states were to sentence only the worst offenders to incarceration, the vulnerability to heat would likely increase using this Index at the state level. Between facilities under a single jurisdiction, like a state, this would be more comparable.

The importance of using granular heat index data, meaning county-level data versus state-level data, is most illustrated by the Late Century, Slow Action runs. For the Late Century, Slow Action state-level heat index run, Arkansas (Southeast) is tied for the highest vulnerability with Ohio (Midwest) and Delaware (Northeast). For the Late Century, Slow Action county-level heat index run, Ohio is the most vulnerable, then Delaware ranked second most vulnerable, then Arkansas ranked third most vulnerable. Ohio ranking most vulnerable in late century is a departure from the other runs, in which Arkansas consistently had the highest vulnerability. This was a surprising result and indicates that the rate of warming in the Midwest and Northeast may exceed that of the Southeast, which is consistent with NCA4 projections (Hayhoe et al. 2018). Despite these increases in projected heat index days above 90°F by the end of the century, Ohio's moderate SVI result keeps overall CFHVI score moderate. Many states are home to multiple climates, and opting for broader, state-wide data might hide some of the nuances associated with heat index data specific to where facilities are located.

Recommendations

Improved data collection and reporting

Data availability was a major obstacle to building and successfully running this Index. The 48 contiguous states all report their data in differing ways, included different variables and statistics, and across various scales and timeframes. Many states offered basic demographic data on incarcerated individuals but locating staff information was more difficult. Of course, there are significant challenges associated with collecting health and other data relating to incarcerated people or employees. Some of these challenges include high turnover rate of incarcerated people; the cost, time, and staffing needs required to collect this data; and potential negative media attention that could arise from uncovering inadequate conditions (Binswanger et al. 2019).

Despite these challenges, recording and reporting data about incarcerated people is a public health concern as much as a criminal justice one. First and foremost, there should be a standardized reporting method for statistics relating to incarcerated people. Binswanger et al. (2019) details how surveillance data can help health care professionals recognize health risks in different populations and inform preventative interventions and care.

Many facilities and municipalities struggle with staffing shortages, high turnover rates, and tight budgets, so making data reporting as straightforward and seamless as possible should be a priority. A federally developed and managed dashboard for aggregating admission and release data as they happen could help track this information without creating 50 disparate data sets and alleviating some of the burden of data analysis on states. The Bureau of Justice Statistics reports some national and state-level data as part of the National Prisoner Statistics (NPS) Program, but this is contingent upon voluntary participation from state departments of corrections and the Federal Bureau of Prisons (Bureau of Justice Statistics 2020). The Centers for Disease Control and Prevention (CDC) has a Correctional Health: Data and Statistics page, which largely redirects to state departments of corrections, the Bureau of Justice

Statistics, or general population health data for select infectious diseases, chronic diseases, and lifestyle choices (CDC 2014). CDC coordinates the National Environmental Public Health Tracking Network that brings together health and environment data from across the country, including heat and health tracking. A partnership between the CDC and the Bureau of Justice Statistics seems like a natural choice for overseeing standardized data collection and reporting about heat in prisons, though additional funding and resources would likely be necessary at both the state and federal levels.

In addition to more detailed demographic data, more detailed tracking of heat-related illnesses and deaths is necessary. This is an issue beyond the correctional sector; due to the nature of heat, and its contribution to other health complications, heat-related illnesses and deaths may be misattributed to other symptoms like heart attack or stroke, and mention of heat may be left off of death certificates (CDC 2017; EPA 2020). Thus, the reported number of heat-related deaths annually is likely an understatement (EPA 2020).

Heat-related illnesses and death are preventable (CDC 2017). Ensuring that inmates and staff are educated on ways to prevent heat-related illness and to recognize their symptoms can reduce their incidence and help get proper medical attention to those in need. The costs associated with hospitalizations, emergency department visits, and death are also high; a single heat wave in Wisconsin was estimated to have cost $252 million in health costs (Limaye 2019). Staff may experience lost wages due to missed days of work, and facilities may face staffing shortages after an extreme heat event. Minimizing these avoidable health costs can help offset the expense of improved reporting, or implementation of heat-adaptive measures.

Implement heat-adaptive measures

Regardless of the results of this CFHVI, one thing is certain: incarcerated people deserve to live without the risk of health complications resulting from heat, increased violence in their facility as a result of higher temperatures, and potential death from extreme heat events. Constitutionally, “reasonable safety” is listed as a basic human need that the State must provide any person taken into custody and held against their will. As temperatures rise, correctional departments may become increasingly vulnerable to lawsuits contesting conditions within their facilities from both released inmates and staff (Holt, 2015). Therefore, it is in states’ best interests beyond the wellbeing of the incarcerated to implement measures that decrease heat exposure in prisons and correctional facilities.

The CFHVI ranks facilities against one another to indicate where resources and funding for adaptive measures should be concentrated, and over differing time frames. This aids in long-term budget and maintenance planning. Making incarceration facilities better prepared to manage heat impacts will likely take years if not decades and having some foresight into future vulnerability may improve health outcomes.

In the meantime, short-term changes can be implemented. If some facilities in a jurisdiction already have certain adaptive cooling measures, are newer, less full, or have more staff, particularly vulnerable inmates and staff can be relocated to better equipped facilities. Characterizing inmates as additionally vulnerable can help concentrate oversight and care to intervene before heat-related illness occurs. Redistributing inmates based on heat vulnerability can also offer the ability to retrofit facilities where it is feasible and affordable to do so and phase out facilities that are too expensive or too difficult to update. In the event that new facilities are needed to manage volume of inmates, these should be built with heat in mind and adaptive measures already integrated (Holt 2015).

Holt (2015) also touches on an important economic and environmental risk: air conditioning. Air conditioning can be expensive to install and maintain, energy intensive, and produces emissions that contribute directly to climate change—the very phenomenon causing these higher temperatures in the first place. The study recommends passive cooling measures made to the exterior of facilities “including cool roofs, green roods and walls, and awnings.” Even if air conditioning is deemed to be necessary, these measures may reduce its use (Holt 2015). When needed, facilities should invest in energy-efficient cooling and air conditioning systems to keep power demand and subsequent emissions low while providing potentially life-saving temperature control (Abel et al. 2019).

Reduce the overall incarcerated population

The United States has less than five percent of the world's total population but is home to nearly a fifth of the world's total prison population (Wagner and Bertram 2015). Holt (2015) recommends that a "rational approach" to reducing heat related illness and complications among incarcerated people and staff is to simply reduce the size of the incarcerated population. Community corrections, rehabilitation and reentry programs, job training and skill building, and other programs that reduce residential incarcerated populations eases the large challenge of climate adaptation facing facility staff and jurisdictions home to correctional facilities. There are a variety of policy options for reducing the prison population, including decriminalizing drug use and possession, changing sentencing and parole practices, and investing in support systems and treatment options that lessen crime (Holt 2015). Shrinking incarcerated populations' volume can alleviate overcrowding, allow for the retrofitting or retirement of older facilities, and better distribute staff among the incarcerated population. While this paper focuses on just the heat impacts on incarcerated people and staff, it can't be ignored that broader criminal justice reform could also benefit inmates in this way.

5. Conclusion

The Correctional Facilities Heat Vulnerability Index (CFHVI) is a simple tool for prison officials to assess the current, medium-term, and long-term vulnerabilities of the populations in their facilities. As discussed, Delaware has high vulnerability to heat, and would likely most benefit from immediate adaptive measures such as fans, air conditioning, and other cooling methods the most, as would Arkansas. Montana and Oregon have relatively low heat index projections, as well as low SVI results, placing them at a lower priority than the other states for adaptive measures. This isn't to suggest that incarcerated populations in these states would not benefit from these measures, but that the vulnerability to heat is higher elsewhere. Examining temperature or heat index data alone paints an incomplete picture of the true vulnerability of a population.

Continued research is needed to better understand the relationships between climate change, extreme heat, health, and incarceration, and how best to protect the vulnerable incarcerated population from extreme heat.

6. Bibliography

Abel, D. W., Holloway, T., Martinez-Santos, J., Harkey, M., Tao, M., Kubes, C., and Hayes, S. (2019). Air quality-related health benefits of energy efficiency in the United States. *Environmental Science and Technology 53*(7):3987-3998. https://pubs.acs.org/doi/full/10.1021/acs.est.8b06417

Alele, F., Malau-Aduli, B., Malau-Aduli, A. and Crowe, M. (2020). Systemic review of gender differences in the epidemiology and risk factors of exertional heat illness and heat tolerance in the armed forces. *BMJ Open 10*(4). https://pubmed.ncbi.nlm.nih.gov/32265238/

American Heart Association (2019, July 1). *Summer heat brings special health risks for pregnant women.* https://www.heart.org/en/news/2019/07/01/summer-heat-brings-special-health-risks-for-pregnant-women#:~:text=Symptoms%20of%20overheating%20include%20warm,stroke%2C%20heat%20exhaustion%20and%20dehydration

Anderson, Craig A. (2001). Heat and violence. *Current Directions in Psychological Science 10*(1):33-38. https://doi.org/10.1111/1467-8721.00109

Anderson, C. A. and Anderson, K. B. (1996). Violent crime rate studies in philosophical context: A destructive testing approach to heat and southern culture of violence effects. *Journal of Personality and Social Psychology 70*(4):740-756. Retrieved from http://web.a.ebscohost.com.proxy1.library.jhu.edu/ehost/pdfviewer/pdfviewer?vid=1&sid=427f841d-9e1f-4db7-ab3a-bbb847408662%40sdc-v-sessmgr03

Arkansas Division of Correction (2019). ADC Fiscal Year 2018 Statistical Information & Trends. https://doc.arkansas.gov/wp-content/uploads/2020/09/ADC_FY18_Statistical_Information_Trends_BOC_Approval_12_20_2018.pdf.

Arkansas Division of Correction (2018). Annual Report FY2017. https://doc.arkansas.gov/wp-content/uploads/2020/09/FY17_Annual_Report_FINAL.pdf

Benns, W. (2015, September 21). *American slavery, reinvented*. The Atlantic. https://www.theatlantic.com/business/archive/2015/09/prison-labor-in-america/406177/

Binsswanger, I. A., Maruschak, L. M., Mueller, S.R., Stern, M.F. et al. (2019). Principles to Guide National Data Collection on the Health of Persons in the Criminal Justice System. *Public Health Reports 134*(1):34S-45S. https://journals.sagepub.com/doi/full/10.1177/0033354919841593

Blinder, A. (2016, August 15). *In U.S. jails, a Constitutional clash over air-conditioning*. New York Times. https://www.nytimes.com/2016/08/16/us/in-us-jails-a-constitutional-clash-over-air-conditioning.html

Bureau of Justice Statistics (2020). *Data collection: National Prisoner Statistics (NPS) Program*. https://www.bjs.gov/index.cfm?ty=dcdetail&iid=269

Carson, E. A. (2020). Prisoners in 2018. *Bureau of Labor Statistics, U.S. Department of Justice*. https://www.bjs.gov/content/pub/pdf/p18.pdf

Carter, L., Terando, A., Dow, K., Hiers, K. et al. (2018). Chapter 19: Southeast, in Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II. *U.S. Global Change Research Program*. https://nca2018.globalchange.gov/chapter/19/

CDC (2014). *Correctional health: Data and statistics*. https://www.cdc.gov/correctionalhealth/health-data.html

CDC (2020). CDC SVI 2016 Documentation. https://svi.cdc.gov/Documents/Data/2016_SVI_Data/SVI2016Documentation.pdf

CDC (2017). Picture of America: Heat Related Illness Fact Sheet. https://www.cdc.gov/pictureofamerica/pdfs/picture_of_america_heat-related_illness.pdf

Colorado Department of Corrections (2017). Colorado Department of Corrections Statistical Report FY2017. https://drive.google.com/file/d/1opCqREUJL0YboXoJrqZtHkQnV5n9a85k/view

Colorado Department of Corrections (2019). *Departmental reports and statistics*. https://www.colorado.gov/pacific/cdoc/departmental-reports-and-statistics

Connelly, M. and Feldman, D. (2014). Resilience in corrections: A proactive approach to changing conditions. *National Institute of Corrections*. https://s3.amazonaws.com/static.nicic.gov/Library/028089.pdf

Crimmins, A., Balbus, J., Gamble, J. L., Beard, C. B., et al (2016). The impacts of climate change on human health in the United States: A scientific assessment. *U.S. Global Change Research Program*. https://health2016.globalchange.gov/

Dahl, K., Spanger-Siegfried, E., Licker, R., Caldas, A. et al. (2019). Killer heat in the United States. *Union of Concerned Scientists.* https://ucsusa.org/resources/killer-heat-united-states-0

Delaware Department of Corrections (2018). FY 2017 Annual Report. https://doc.delaware.gov/assets/documents/annual_report/DOC_2017AnnualReport.pdf.

EPA (2020). *Climate change indicators: Heat-related deaths*. https://www.epa.gov/climate-indicators/climate-change-indicators-heat-related-deaths

Fathi, D. (2018, November 15). *Prisoners are getting paid $1.45 a day to fight California wildfires.* ACLU. Retrieved from https://www.aclu.org/blog/prisoners-rights/prisoners-are-getting-paid-145-day-fight-california-wildfires

Flanagan, B. E., Gregory, E. W., Hallisey, E. J., Heitgerd, J. L., and Lewis, B. (2011). A Social Vulnerability Index for Disaster Management. *Journal of Homeland Security and Emergency Management 8*(1):3. Retrieved from https://svi.cdc.gov/A%20Social%20Vulnerability%20Index%20for%20Disaster%20Management.pdf

Hayhoe, K., Doherty, S., Kossin, J. P., Sweet, W. V. et al. (2018). Chapter 2: Our Changing Climate. In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*. U.S. Global Change Research Program. Retrieved from https://nca2018.globalchange.gov/chapter/2/

Holt, D. W. E. (2015). Heat in US Prisons and Jails. *Columbia Law School Sabin Center for Climate Change Law*. https://web.law.columbia.edu/sites/default/files/microsites/climate-change/holt_-_heat_in_us_prisons_and_jails.pdf

Jay, A., Avery, C. W., Barrie, D., Dave, A. et al. (2018). Overview. In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*. U.S. Global Change Research Program. Retrieved from https://nca2018.globalchange.gov/chapter/1/

Jones, A. (2019, June 18). *Cruel and unusual punishment: When states don't provide air conditioning in prison.* Prison Policy Initiative. https://www.prisonpolicy.org/blog/2019/06/18/air-conditioning/

Kansas Department of Corrections (2013). *Adult facility index*. https://www.doc.ks.gov/facilities/index

Kansas Department of Corrections (2018). Annual Report Fiscal Year 2017. https://www.doc.ks.gov//publications/Reports/2017/view

Limaye, V. (2019). Bitter pill: The high health costs of climate change. *NRDC*. https://www.nrdc.org/sites/default/files/bitter-pill-high-costs-climate-change-fs.pdf

Mares, D. M. and Moffett, K. W. (2019). Climate change and crime revisited: An exploration of monthly temperature anomalies and UCR crime data. *Environment and Behavior 51*(5):502-529. https://journals.sagepub.com/doi/abs/10.1177/0013916518781197

Miles-Novelo, A. and Anderson, C. A. (2019). Climate change and psychology: Effects of rapid global warming on violence and aggression. *Current Climate Change Reports 5*:36-46. https://link.springer.com/article/10.1007/s40641-019-00121-2

Montana Department of Corrections (2020). 2019 Biennial Report. https://cor.mt.gov/Portals/104/Resources/Reports/2019BiennialReport.pdf

Mora, C., Counsell, C. W. W., Bielecki, C. R., and Louis, L. V. (2017). Twenty-seven ways a heat wave can kill you: Deadly heat in the era of climate change. *Circulation 10*(11). https://www.ahajournals.org/doi/full/10.1161/CIRCOUTCOMES.117.004233

National Weather Service (2019). *Weather related fatality and injury statistics.* National Oceanic and Atmospheric Administration. https://www.weather.gov/hazstat/

National Weather Service (n.d.). *What is the heat index?* National Oceanic and Atmospheric Administration. https://www.weather.gov/ama/heatindex

NIOSH (2020). *Heat stress.* Centers for Disease Control and Prevention https://www.cdc.gov/niosh/topics/heatstress/default.html

Ohio Department of Corrections (2018). January 2018 Census of ORDC Institutional Population Report. https://www.drc.ohio.gov/Portals/0/Reentry/Reports/Institution%20Census/INSTITUTION%20CENSUS%20JANUARY%202018.pdf?ver=2018-01-29-091451-483

Ohio Department of Corrections (2018). Monthly Fact Sheet January 2018. https://www.drc.ohio.gov/Portals/0/Reentry/Reports/Staffing/2018/January%202018.pdf?ver=2018-01-02-102246-913

Ohio Department of Corrections (2020). *ODRC Institutions*. https://drc.ohio.gov/institutions.

Oregon Department of Corrections (2019). Affirmative Action Plan 2019 – 2021 Biennium. https://www.oregon.gov/doc/Documents/affirmative-action-plan-2019-2021.pdf

Oregon Department of Corrections (n.d.). *Prison locations.* https://www.oregon.gov/doc/about/Pages/prison-locations.aspx

Oregon Department of Corrections (2019). Quick Facts. https://www.oregon.gov/doc/Documents/agency-quick-facts.pdf

Prison Policy Initiative (2020). Percentage of incarcerated state prison population 55 years of age and older for each state, with comparative total prison population counts. https://www.prisonpolicy.org/data/older_prisonpopulations.xlsx

Public Health Institute (2016). *Extreme heat, climate change and health.* https://climatehealthconnect.org/wp-content/uploads/2016/09/ExtremeHeat.pdf

Salas, R. N., Knappenberger Lester, P., and Hess, J. (2020). 2020 Lancet Countdown on Health and Climate Change Policy Brief for the United States of America. *Lancet Countdown*. http://www.lancetcountdownus.org/wp-content/uploads/2020/12/FINAL-2020_12_02_Lancet-Countdown-Policy-Document-USA-ENG.pdf?hsCtaTracking=3d902c23-c855-441f-ab5d-61f4f76a2ea1%7C6d90df30-4bf7-42f3-a282-f61d5292a03e

Sawyer, W. and Wagner, P. (2020). Mass incarceration: The whole pie 2020. *Prison Policy Initiative*. https://www.prisonpolicy.org/reports/pie2020.html

Sawyer, W. (2017). *How much do incarcerated people earn in each state?* Prison Policy Initiative. https://www.prisonpolicy.org/blog/2017/04/10/wages/

Stephan, J. J. (2008). Census of state and federal correctional facilities, 2005. *Bureau of Justice Statistics.* https://www.bjs.gov/content/pub/pdf/csfcf05.pdf

Stevens, H. R., Beggs, P. J., Graham, P. L., and Chang, H-C. (2019). Hot and bothered? Associations between temperature and crime in Australia. *International Journal of Biometeorology 63*:747-762. https://link.springer.com/article/10.1007/s00484-019-01689-y

Sufrin, C., Beal, L., Clarke, J., Jones, R., and Mosher, W. D. (2019). Pregnancy outcomes in US prisons, 2016-2017. *American Journal of Public Health 109*(5):799-805. https://ajph.aphapublications.org/doi/10.2105/AJPH.2019.305006

U.S. Census Bureau (2019). *QuickFacts.* https://www.census.gov/quickfacts/fact/table/US/PST045219

Vaidyanathan, A., Malilay, J., Schramm, P., and Saha, S. (2020). Heat-related deaths – United States, 2004-2018. *CDC*. https://www.cdc.gov/mmwr/volumes/69/wr/mm6924a1.htm

Wagner, P. and Bertram, W. (2020). *What percent of the U.S. is incarcerated? (And other ways to measure mass incarceration).* Prison Policy Initiative. https://www.prisonpolicy.org/blog/2020/01/16/percent-incarcerated/

Williams, A. A., Allen, J. G., Catalano, P. J., et al. (2020). The influence of heat on daily police, medical, and fire dispatches in Boston, Massachusetts: Relative risk and time-series analysis. *American Journal of Public Health 110*(5):662-668. https://ajph.aphapublications.org/doi/full/10.2105/AJPH.2019.305563

Curriculum Vitae

CLARE MORGANELLI

Objective

Graduating with a master's degree in Energy Policy and Climate from Johns Hopkins University to continue the fight against climate change with a focus on adaptation measures and community resilience.

Experience

September 2017 to Present	Program Assistant, Climate Program | *Natural Resources Defense Council* Washington, DC • Supporting a team of advocates, experts, and litigators on research, writing and editing publications, blogs, and presentations, and interfacing with outside partners. • Overseeing budget management, expense reporting, scheduling, and coordination across teams and with outside parties. • Primary focus is on climate change, adaptation, and health. • Building organizational, communication, writing, and researching skills.
September 2016 to May 2017	Operations Intern | *NC State Waste Reduction and Recycling Office* Raleigh, North Carolina • Responsible for creating and maintaining various spreadsheets and reports to manage waste production and collection data from NC State's campus. • Organized educational outreach activities to improve public knowledge and participation in waste reduction opportunities. • Conducted waste audits and site assessments and developed new programs for waste reduction. • Built digital and public communications, data analysis, and writing skills.
July 2016 to August 2016	RCRA Pathways Intern | *U.S. Environmental Protection Agency, Region 4* Atlanta, Georgia • Contributed to projects under the purview of the Resource Conservation and Recovery Act (RCRA), such as the WRAP plastics recycling program, Community-Based Composting in Atlanta, and Atlanta Recycles. • Represented EPA/RCRA team at a Southeastern NEPA conference. • Designed and formatted a State Measurement Program results booklet that was distributed at a national RCRA conference. • Built government and stakeholder communication skills, and design skills.
October 2015 to May 2016	*BioResources Journal* Pre-Editor | *NC State College of Natural Resources* Raleigh, North Carolina • Edited journal submissions for grammar, usage, and tense, as well as formatting the layout and citations according to APA criteria. • Often involved articles translated from other languages, requiring additional attention to detail and understanding of subject matter. • Improved writing, editing, and citation skills.

Education

June 2019 to December 2020	Candidate: MSc Energy Policy and Climate | *Johns Hopkins University* Baltimore, Maryland Capstone: "Developing a Heat-Related Vulnerability Index for Correctional Facilities" 3.96/4.00 GPA (excluding Fall 2020 semester)
August 2013 to May 2017	BS Sustainable Materials and Technology | *North Carolina State University* Raleigh, North Carolina 3.23/4.00 GPA Dean's List: Spring 2015, Fall 2015, Spring 2016, Fall 2016, Spring 2017

Publications and Writing

- Constible, J., Chang, B., Morganelli, C. and Blandon, N. (2020). On the front lines: Climate change threatens the health of America's workers. NRDC. https://www.nrdc.org/sites/default/files/front-lines-climate-change-threatens-workers-report.pdf
- Morganelli, C. (2020, September 17). School's back: How COVID-19 and heat jeopardize learning. NRDC. https://www.nrdc.org/experts/clare-morganelli/schools-back-how-covid-19-and-heat-jeopardize-learning
- Morganelli, C. (2020, March 20). Doing the dirty work: Resilience workers deserve better. NRDC. https://www.nrdc.org/experts/clare-morganelli/doing-dirty-work-resilience-workers-deserve-better
- Constible, J., Patel, D., Rubright, S., and Morganelli, C. (2019, September). Climate change and health in Illinois. NRDC. https://www.nrdc.org/sites/default/files/climate-change-health-impacts-illinois-ib.pdf
- Constible, J., Berquist, K., and Morganelli, C. (2019, September). Climate change and health in Washington. NRDC. https://www.nrdc.org/sites/default/files/climate-change-health-impacts-washington-ib.pdf
- Morganelli, C. (2019, August 20). Lack of heat safety standard a risk to postal worker health. NRDC. https://www.nrdc.org/experts/clare-morganelli/lack-heat-safety-standard-risk-postal-worker-health
- Morganelli, C. (2019, June 24). What I wish I heard at the climate resilience hearing. NRDC. https://www.nrdc.org/experts/clare-morganelli/what-i-wish-i-heard-climate-resilience-hearing
- Morganelli, C. (2019, April 1). Climate adaptation shouldn't fuel inequitable displacement. NRDC. https://www.nrdc.org/experts/clare-morganelli/climate-adaptation-shouldnt-fuel-inequitable-displacement
- Constible, J., Morganelli, C., and Berquist, K. (2019, February). Climate change and health in California. NRDC. https://www.nrdc.org/sites/default/files/climate-change-health-impacts-california-ib.pdf
- Constible, J., Reiser, L., and Morganelli, C. (2019, January). Climate change and health in Michigan. NRDC. https://www.nrdc.org/sites/default/files/climate-change-health-impacts-michigan-ib.pdf
- Morganelli, C. (2019, January 8). Climate change won't play fair when it comes to kids' health. NRDC. https://www.nrdc.org/experts/clare-morganelli/climate-change-wont-play-fair-when-it-comes-kids-health
- Morganelli, C. (2018, August 30). Addressing climate-related inequality with local healthcare. NRDC. https://www.nrdc.org/experts/clare-morganelli/addressing-climate-related-inequality-local-healthcare

- Morganelli, C. (2018, June 26). Antibiotic resistance & climate change: A dangerous duo. NRDC. https://www.nrdc.org/experts/clare-morganelli/antibiotic-resistance-climate-change-dangerous-duo
- Constible, J. and Morgenlli, C. (2018, June). Climate change and health in Colorado. NRDC. https://www.nrdc.org/sites/default/files/climate-change-health-impacts-colorado-ib.pdf
- Constible, J. and Morganelli, C. (2018, April 11). Doctors prescribe climate action for better health. NRDC. https://www.nrdc.org/experts/juanita-constible/doctors-prescribe-climate-action-better-health
- Morganelli, C. (2018, February 15). Erasing climate change from EPA's budget won't fix the problem. NRDC. https://www.nrdc.org/experts/clare-morganelli/erasing-climate-change-epa-budget-wont-fix-problem
- Morganelli, C. (2018, January 4). Comment now on Trump's EPA attack on our health. NRDC. https://www.nrdc.org/experts/juanita-constible/comment-now-trumps-epa-attack-our-health
- Morganelli, C. (2017, October 16). Reinforcing healthcare systems in the age of stronger storms. NRDC. https://www.nrdc.org/experts/juanita-constible/reinforcing-healthcare-systems-age-stronger-storms

Institutional Involvement

- NRDC DC Diversity, Equity, and Inclusion (DEI) Committee member (September 2017 to present)
    - NRDC DC DEI Education Subcommittee member (January 2020 to present)
- NRDC DC Women's Caucus member (January 2018 to present)
    - NRDC DC Women's Caucus Planning Committee member (January 2020 to present)
- NRDC Program Assistants Committee member (January 2019 to January 2020)

Skills

- Microsoft Office (Word, Excel, PowerPoint, Outlook, Sharepoint, Workplace)
- Adobe Creative Suite (Illustrator, InDesign, Photoshop, DreamWeaver)
- SolidWorks
- AutoCAD
- HTML/CSS